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On the Simbol-X capability of detecting red/blue-shifted emission and absorption Fe K lines

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Abstract. The detection of red/blue-shifted iron lines in the spectra of astronomical X-ray sources is of great importance, as it allows to trace the environment around compact objects, like black holes in AGNs. We report on extensive simulations to test the *Simbol-X* capability of detecting such spectral features, focusing on the low energy detector (~0.5–30 keV).

Key words. Line: profiles – Telescopes – X-rays: general – X-rays: galaxies

1. Introduction

Inflows and outflows are thought to be complementary processes in accreting black hole (BH) systems, from stellar mass to AGNs. Recently detected narrow red-shifted emission lines in the 4–6 keV band of several AGN spectra have been interpreted as red wings to the Fe Kα line, shifted by Doppler and gravitational effects. These clearly indicate the presence of Compton thick matter down to few gravitational radii from the BH, possibly located in an accretion disc (e.g. Iwasawa et al. 2004). Moreover, several AGN spectra show evidence for absorption features at energies greater than 7 keV, consistent with blue-shifted lines from highly ionized iron. These are instead distinctive of massive outflows or ejecta originating close to the central BH, with velocities ~0.1–0.2 c (for a review see Cappi 2006). The planned French-Italian X-ray satellite *Simbol-X*, with high sensitivity in the broad 0.5–80 keV band, will surely improve the detection of red/blue-shifted iron emission and absorption lines. Focusing on the performances of the low energy detector (~0.5–30 keV), we analyzed the *Simbol-X* capability of detecting such spectral features with extensive simulations.

2. Red-shifted emission line simulations

The latest *Simbol-X* response files[1] have been used to carry out spectral simulations. We assumed a power-law continuum with Γ fixed to 1.9 and variable normalization. An emission line sampling the 4–7 keV energy range, fixing equivalent widths to 25 and 50 eV and exposure times to 50 and 100 ks has then been added. For each simulated spectrum the $\Delta\chi^2$ associated to the addition of a Gaussian

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[1] http://www.iasfbo.inaf.it/simbolx/faqs.php

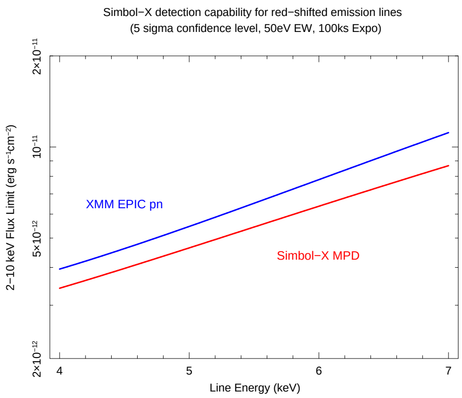

Fig. 1. Comparison of the *Simbol-X* and *XMM-Newton* simulations for red-shifted emission lines. The 2–10 keV flux limit is plotted against energy for the detection of an emission line at 5 sigma confidence level. Equivalent width of 50 eV, exposure of 100 ks and nominal background level have been assumed.

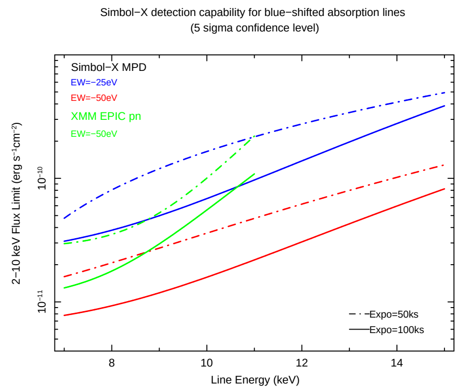

Fig. 2. Comparison of the *Simbol-X* and *XMM* simulations for blue-shifted absorption lines. The 2–10 keV flux limit is plotted against energy for the detection of an absorption line at 5 sigma confidence level. Equivalent widths are −25 and −50 eV, exposure times of 50 and 100 ks and background level at the nominal value.

line to the continuum fit has been recorded. The statistical confidence level of the detection has then been estimated by means of an F-test. The results are reported in Fig. 1, with a comparison to the EPIC pn instrument on-board *XMM-Newton*. *Simbol-X* will be about 30% more sensitive than the pn at energies below 6 keV. We also found that factors of 10 respect to the nominal background level of 3×10^{-4} cts cm^{-2} s^{-1} keV^{-1} will affect only ± 20% the flux limit. Moreover, the instrument capability will allow to perform time-resolved spectral analysis of such features on time-scales of few ks for sources with fluxes greater than $\sim 10^{-12}$ erg s^{-1} cm^{-2} (e.g. Tombesi et al. 2007). Thanks to the high energy detector (~10–80 keV) it would be even possible to reveal correlations between variation of the red-shifted features and the expected high energy reflection hump.

3. Blue-shifted absorption line simulations

The same procedure used for emission lines has been used to test blue-shifted absorption lines detectability. We assumed a power-law continuum with $\Gamma = 1.9$ and variable normalization. An absorption line was then added sampling the 7–15 keV energy range, fixing equivalent widths to −25 and −50 eV and exposure times to 50 and 100 ks. For each spectrum the $\Delta\chi^2$ associated to the addition of an absorption line to the primary continuum fit was recorded and used to derive an estimation of the detection confidence level. Fig. 2 shows the result of our simulations, together with a comparison of the EPIC pn instrument. *Simbol-X* will be more than 2 times better than the pn, also allowing high detection capability up to 15 keV. In particular, it will be able to clearly detect narrow absorption lines of equivalent widths between −20 and −50 eV at energies up to 12 keV for sources with flux of the order of 10^{-11} erg s^{-1} cm^{-2}. Also in this case we found that factors of 10 with respect to the nominal background level will affect only ± 20% the flux limit.

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